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Public aquaria as long-term enrichments for investigating planktonic Archaea

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The most abundant group of planktonic Archaea , the so-called Thaumarchaeota, represents 20% of all marine planktonic microorganisms (Karner et al., 2001) and their energy efficient performance of nitrification makes them key players in the global nitrogen- and carbon-cycle (Könneke et al., 2014). Furthermore, planktonic Archaea are considered to be the major producers of specific microbial membrane lipids that are extensively used as paleoproxies in marine climate research (Schouten et al., 2002). Therefore, assessing the parameters controlling the distribution of Archaea in the marine water column is crucial for studies of modern and past marine environments.

Although diverse studies utilizing DNA- and biomarker-based approaches have constrained the turnover and distribution of marine Archaea, the environmental factors affecting their abundance and activity (e.g., Wuchter et al., 2006; Bale et al., 2013) are still poorly understood. Further, previous surveys, using enrichment cultivation and pure culture experiments, provided valuable information on adaptation of planktonic Archaea to changes of parameters affecting growth conditions, such as temperature, salinity and growth stage (Elling et al., 2014, 2015). Hence, we know that planktonic Archaea directly adapt their membranes to changing growth conditions, but also that environmental selection for individual phylogenetic groups of these organisms is also reflected in the membrane lipid pool.

Extending these studies, this project further aims at constraining the environmental parameters controlling archaeal abundance in the marine environment. Public aquaria, which are comparable to perfectly monitored long-term enrichment cultures, are optimal sampling sites for this task. A comprehensive set of 120 water and substrate samples from fresh, marine and brackish systems exhibiting diverse conditions was selected from 15 public aquaria at the east and west coast of the USA. These samples were examined for their archaeal intact polar and core membrane lipid composition. We detected a set of more than 90 different lipid structures comprised of diverse glyco- as well as phospho- based head groups combined with di- and tetraether cores containing up to 5 cyclopentane rings or unsaturations. The correlation of the variability within the lipid portfolio with the 30 different environmental variables, measured in the individual tanks, like e.g., water chemistry, light availability and temperature will lead to a better understanding of the factors controlling planktonic archaeal distribution in the marine environment and the derived lipid-based proxies.

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